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09/759,854	01/12/2001	Christopher Ngai	A4467/T3500	1861

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APPLIED MATERIALS, INC.  
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SANTA CLARA, CA 95050

EXAMINER

BREWSTER, WILLIAM M

ART UNIT PAPER NUMBER

2823

DATE MAILED: 04/09/2003

Please find below and/or attached an Office communication concerning this application or proceeding.

# Office Action Summary

Application No.

09/759,854

Applicant(s)

NGAI ET AL.

Examiner

William M. Brewster

Art Unit

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

## Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

## Status

- 1) ☒ Responsive to communication(s) filed on 08 July 2002.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

## Disposition of Claims

- 4) ☒ Claim(s) 1-30 is/are pending in the application.
- 4a) Of the above claim(s) 29 and 30 is/are withdrawn from consideration.
- 5) ☐ Claim(s) \_\_\_\_\_ is/are allowed.
- 6) ☒ Claim(s) 1-20 and 22-30 is/are rejected.
- 7) ☒ Claim(s) 21 is/are objected to.
- 8) ☐ Claim(s) \_\_\_\_\_ are subject to restriction and/or election requirement.

## Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on \_\_\_\_\_ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
- Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
- 11) ☐ The proposed drawing correction filed on \_\_\_\_\_ is: a) ☐ approved b) ☐ disapproved by the Examiner.
- If approved, corrected drawings are required in reply to this Office action.
- 12) ☐ The oath or declaration is objected to by the Examiner.

## Priority under 35 U.S.C. §§ 119 and 120

- 13) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some \* c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. \_\_\_\_\_.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
- \* See the attached detailed Office action for a list of the certified copies not received.
- 14) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).
- a) ☐ The translation of the foreign language provisional application has been received.
- 15) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

## Attachment(s)

- 1) ☒ Notice of References Cited (PTO-892)
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- 3) ☒ Information Disclosure Statement(s) (PTO-1449) Paper No(s) 2, 3.
- 4) ☐ Interview Summary (PTO-413) Paper No(s). \_\_\_\_\_.
- 5) ☐ Notice of Informal Patent Application (PTO-152)
- 6) ☐ Other: \_\_\_\_\_.

## **DETAILED ACTION**

### ***Election/Restrictions***

Restriction to one of the following inventions is required under 35 U.S.C. 121:

- I. Claims 1-28, drawn to the nitrogen doping of FSG layers, classified in class 438, subclass 779.
- II. Claims 29-30, drawn to controlling the process chamber operations conducting Nitrogen doping, classified in class 700, subclass 121.

The inventions are distinct, each from the other because of the following reasons:

Inventions I and II are related as process and apparatus for its practice. The inventions are distinct if it can be shown that either: (1) the process as claimed can be practiced by another materially different apparatus or by hand, or (2) the apparatus as claimed can be used to practice another and materially different process. (MPEP § 806.05(e)). In this case the depositing a layer on a substrate defined in claim 1, may be made using a plasma generating system with a single set of instructions as opposed to the three sets required by claim 29.

Because these inventions are distinct for the reasons given above and the search required for Group II is not required for Group I, restriction for examination purposes as indicated is proper.

During a telephone conversation with Examiner Walter R. Swindell and Chun-Pok Leung (Patent Bar Registration No. 41,405) on 18 December 2002 a provisional election was made with traverse to prosecute the invention of group I, claims 1-28.

**DETAILED ACTION**

***Response to Amendment***

1. The proposed reply filed on 8 July 2002 (Paper #4) has been entered.

***Information Disclosure Statement***

2. The information disclosure statement (IDS) submitted on 2 July 2001 (Paper #2) and 08 July 2002 (Paper #3) was filed before the mailing date of the first Office Action. The submission is in compliance with the provisions of 37 CFR 1.97. Accordingly, the information disclosure statement is being considered by the examiner.

***Claim Objections***

3. Claims 10-13, 23, and 24 are objected to because of the following informalities: The "at." term that appears before the % is presently understood to be a postscript error of some kind. Appropriate correction is required.

***Election/Restrictions***

4. Restriction to one of the following inventions is required under 35 U.S.C. 121:
  - I. Claims 1-28, drawn to the Nitrogen doping of FSG layers, classified in class 438, subclass 779.
  - II. Claims 29-30, drawn to a system for controlling the process chamber operations conducting Nitrogen doping, classified in class 700, subclass 121.
5. In a telephone conference on 18 December 2002, Applicant's election with traverse of Group 1 (Claims 1-28) is acknowledged.

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Affirmation of this election must be made by applicant in replying to this Office action.

Claims 29-30 withdrawn from further consideration by the examiner, 37 CFR 1.142(b), as being drawn to a non-elected invention.

Applicant is reminded that upon the cancellation of claims to a non-elected invention, the inventorship must be amended in compliance with 37 CFR 1.48(b) if one or more of the currently named inventors is no longer an inventor of at least one claim remaining in the application. Any amendment of inventorship must be accompanied by a request under 37 CFR 1.48(b) and by the fee required under 37 CFR 1.17(i).

### ***Claim Rejections - 35 USC § 102***

The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(e) the invention was described in (1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent or (2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent, except that an international application filed under the treaty defined in section 351(a) shall have the effects for purposes of this subsection of an application filed in the United States only if the international application designated the United States and was published under Article 21(2) of such treaty in the English language.

Claims 1, 5-8, 14 are rejected under 35 U.S.C. 102(e) as being anticipated by Singh et al., U.S. Patent No. 6,191,046 B1.

Singh anticipates, in fig. 1A, a method for depositing a layer on a substrate 20 having a barrier layer 25 in a process chamber, the method comprising: supplying a gaseous mixture to the process chamber, the gaseous mixture comprising a silicon-

containing gas, TEOS, a fluorine-containing gas,  $\text{SiF}_4$ , an oxygen-containing gas,  $\text{O}_2$ , and a nitrogen-containing gas,  $\text{N}_2$ ; and providing energy to the gaseous mixture to deposit a nitrogen-containing fluorinated silicate glass layer onto the burner layer, a PECVD method, col. 9, lines 26-45.

Claims 18-20, 22, 25-28 are rejected under 35 U.S.C. 102(e) as being anticipated by Lin, et al., U.S. Patent No. 6,342,448 B1.

Lin anticipates a method of forming a layer on a substrate in a process chamber, the method comprising: in fig. 3A, supplying a gaseous mixture to the process chamber, the gaseous mixture comprising a silicon-containing gas, a fluorine-containing gas, an oxygen-containing gas, col. 6, line 66 - col. 7, line 13; providing energy to the gaseous mixture, to deposit a nitrogen-containing fluorinated silicate glass layer onto the substrate; forming a fluorinated silicate glass layer 48, 52 over the substrate 40; wherein the gaseous mixture further includes an inert gas, inherent to a PECVD, wherein providing energy comprises forming a plasma from the gaseous mixture in the process chamber, *ibid*; in fig. 3C, forming a patterned photoresist layer 60 over the fluorinated silicate glass layer; etching the fluorinated silicate glass layer according to the patterned photoresist layer; in fig. 3D, removing the photoresist layer and substantially simultaneously introducing nitrogen dopants into the fluorinated silicate glass layer by subjecting the photoresist layer and the fluorinated silicate glass layer to a plasma formed from a nitrogen-containing gas, col. 6, line 66 - col. 8, line 21; wherein the nitrogen-containing gas is selected from the group consisting of  $\text{N}_2$  and  $\text{NH}_3$ , wherein

the nitrogen-containing gas comprises at least one of  $N_2$  and  $NH_3$ :  $N_2$  plasma, col. 7, line 54 - col. 8, line 4; wherein nitrogen dopants are incorporated into the fluorinated silicate glass layer in a region near a surface of the fluorinated silicate glass layer which is exposed to the plasma formed from the nitrogen-containing gas, inherently due to the plasma ashing of the photoresist; in fig. 3E, forming a barrier layer over the nitrogen-containing fluorinated silicate glass layer; wherein the barrier layer comprises at least one of silicon-carbon, silicon nitride, tantalum and tantalum nitride: tantalum and tantalum nitride, col. 8, lines 4-21; in fig. 3F, forming a metal layer over the barrier layer; wherein the metal layer comprises copper, col. 9, lines 26-45.

### ***Claim Rejections - 35 USC § 103***

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

Claims 2-4, 9-13, 15-17 are rejected under 35 U.S.C. 103(a) as being unpatentable over Singh as applied to claims 1, 5-8, 14 above, and further in view of Lin.

Singh teaches in fig. 1A, forming a fluorosilicate glass (FSG) wherein the silicon-containing gas comprises TEOS, the fluorine-containing gas comprises  $SiF_4$  and the oxygen-containing gas comprises  $O_2$ , with  $N_2$  in a PECVD, col. 5, lines 37-43. Singh

anticipates, in fig. 1A, a method for depositing a layer on a substrate 20 having a barrier layer 25 in a process chamber, the method comprising: supplying a gaseous mixture to the process chamber, the gaseous mixture comprising a silicon-containing gas, TEOS, a fluorine-containing gas,  $\text{SiF}_4$ , an oxygen-containing gas,  $\text{O}_2$ , and a nitrogen-containing gas,  $\text{N}_2$ ; and providing energy to the gaseous mixture to deposit a nitrogen-containing fluorinated silicate glass layer onto the barrier layer, a PECVD method, col. 9, lines 26-45.

Singh does not teach forming a copper metal layer over a Ta or TaN barrier layer over the NFSG, but Lin does. Lin teaches a method of forming a layer on a substrate in a process chamber, the method comprising: in fig. 3A, supplying a gaseous mixture to the process chamber, the gaseous mixture comprising a silicon-containing gas, a fluorine-containing gas, an oxygen-containing gas, col. 6, line 66 - col. 7, line 13; providing energy to the gaseous mixture, to deposit a nitrogen-containing fluorinated silicate glass layer onto the substrate; forming a fluorinated silicate glass layer 48, 52 over the substrate 40; wherein the gaseous mixture further includes an inert gas, inherent to a PECVD, wherein providing energy comprises forming a plasma from the gaseous mixture in the process chamber, *ibid*; in fig. 3C, forming a patterned photoresist layer 60 over the fluorinated silicate glass layer; etching the fluorinated silicate glass layer according to the patterned photoresist layer; in fig. 3D, removing the photoresist layer and substantially simultaneously introducing nitrogen dopants into the fluorinated silicate glass layer by subjecting the photoresist layer and the fluorinated silicate glass layer to a plasma formed from a nitrogen-containing gas, col. 6, line 66 -



col. 8, line 21; wherein the nitrogen-containing gas is selected from the group consisting of  $N_2$  and  $NH_3$ , wherein the nitrogen-containing gas comprises at least one of  $N_2$  and  $NH_3$ :  $N_2$  plasma, col. 7, line 54 - col. 8, line 4; wherein nitrogen dopants are incorporated into the fluorinated silicate glass layer in a region near a surface of the fluorinated silicate glass layer which is exposed to the plasma formed from the nitrogen-containing gas, inherently due to the plasma ashing of the photoresist; in fig. 3E, forming a barrier layer over the nitrogen-containing fluorinated silicate glass layer; wherein the barrier layer comprises at least one of silicon-carbon, silicon nitride, tantalum and tantalum nitride: tantalum and tantalum nitride, col. 8, lines 4-21; in fig. 3F, forming a metal layer over the barrier layer; wherein the metal layer comprises copper. Lin gives motivation in col. 3, lines 1-8. It would have been obvious to a person of ordinary skill in the art at the time the invention was made to recognize that combining Lin's process with Singh's invention would have been beneficial because it improves the adhesion of TaN copper diffusion barrier layer.

Claims 23-24 rejected under 35 U.S.C. 103(a) as being unpatentable over Lin as applied to claims 18-20, 22, 25-28 above.

Neither Singh nor Lin does not specify the flow rate of nitrogen or the atomic % of nitrogen in the fluorinated silicate glass layer. It follows that since the plasma ashing procedure uses nitrogen, some, but not much would diffuse into the fluorinated silicate glass layer, reasonably 0.03-0.08 at. % of nitrogen could be achieved. Even if Lin does not teach this, the numbers may be optimized.

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"Normally, it is to be expected that a change in temperature, or in concentration, or in both, would be an unpatentable modification. Under some circumstances, however, changes such as these may impart patentability to a process if the particular ranges claimed produce a new and unexpected result which is different in kind and not merely degree from the results of the prior art . . . such ranges are termed 'critical ranges' and the applicant has the burden of proving such criticality . . . More particularly, where the general conditions of a claim are disclosed in the prior art, it is not inventive to discover the optimum or workable ranges by routine experimentation."

In re Aller 105 USPQ 233, 255 (CCPA 1955). See also In re Waite 77 USPQ 586 (CCPA 1948); In re Scherl 70 USPQ 204 (CCPA 1946); In re Irmischer 66 USPQ 314 (CCPA 1945); In re Norman 66 USPQ 308 (CCPA 1945); In re Swenson 56 USPQ 372 (CCPA 1942); In re Sola 25 USPQ 433 (CCPA 1935); In re Dreyfus 24 USPQ 52 (CCPA 1934).

Note that the specification contains no disclosure of either the critical nature of the claimed dimensions of any unexpected results arising there from. Where patentability is aid to be based upon particular chosen dimensions or upon another variable recited in a claim, the Applicant must show that the chosen dimensions are critical. In re Woodruff, 919 F.2d 1575, 1578, 16 USPQ2d 1934, 1936 (Fed. Cir. 1990).

### ***Allowable Subject Matter***

Claim 21 is objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.


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Any inquiry concerning this communication or earlier communications from the examiner should be directed to William M. Brewster whose telephone number is 703-305-5906. The examiner can normally be reached on Full Time.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Olik Chaudhuri can be reached on 703-306-2794. The fax phone numbers for the organization where this application or proceeding is assigned are 703-305-3432 for regular communications and 703-305-3432 for After Final communications.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is 703-308-0956.

WB  
April 2, 2003

  
Olik Chaudhuri  
Supervisory Patent Examiner  
Technology Center, 2823